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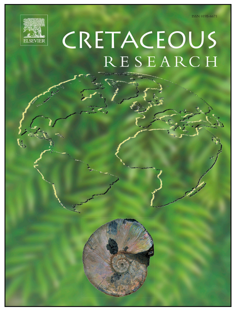

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A new Plotosaurini mosasaur skull from the upper Maastrichtian of Antarctica. Plotosaurini paleogeographic occurrences.

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Abstract. During the Antarctic summer campaigns and as a result of paleontological fieldworks 2013-2015 several mosasaur remains have been collected from the upper Maastrichtian López de Bertodano Formation exposed at Marambio (=Seymour) Island, of the Antarctic Peninsula. One of these specimens preserves part of the skull and dentition, which represent one of the few known skulls from Antarctica. The new specimen (MLP 15-I-24-41) is similar to member of the mosasaur tribe Plotosaurini, sharing the same fronto-parietal suture pattern, and a similar dental morphology as some of the species assigned to the genus. As the specimen is not complete enough to propose a new name it is referred to *Mosasaurus* sp. The presence of these remains on the southern hemisphere represents one of the most complete records of a *Mosasaurus* mosasaur.

Keywords: Upper Cretaceous, Marambio Island, Antarctic Peninsula, Mosasaur.

1. Introduction

Mosasaurs were a very successful group of marine reptiles that invaded the marine realm during the late Cretaceous period and developed a fully marine lifestyle (Polcyn et al. 1999, 2003, 2014). The earliest records of mosasaur remains belong to the Cenomanian of Israel (Polcyn et al. 1999), while the youngest ones have been recovered from various Maastrichtian deposits around the world (Mulder et al. 1998, Kiernan, 2002, Gallagher, 2005, Martin, 2006, Fernández et al. 2008, Bardet et al. 2014, Fernández and Talevi 2015, Milàn et al. 2017).

Mosasaurus Conybeare 1822 is one of the most frequent and widespread taxa, with a life history that extends from the Campanian up to the late Maastrichtian (Polcyn et al. 2014, Street and Caldwell 2016). Fossils referred to this genus have been reported in all continents including

Antarctica (Fernández and Gasparini, 2012). The taxonomy and diversity of its type species, *Mosasaurus hoffmannii* Mantell (1829), has been recently clarified. Street and Caldwell (2016) provided a detailed description and an emended diagnosis, providing a robust basis for comparison and identification of fossils referred to this taxon, and reviewed the validity status of the different species referred to this genus.

In the past 30 years, collaborative paleontological expeditions to the Antarctic Peninsula have been carried out by the staff of the Museo de la Plata (Universidad Nacional de la Plata, Argentina) and the Instituto Antártico Argentino (IAA) during summer field seasons (Campañas Argentinas de Verano, CAV's). Particularly, late Maastrichtian levels of the López de Bertodano Formation (Rinaldi et al. 1978, Macellari 1988, Olivero 2012), outcropping at Marambio (=Seymour) Island, have yielded significant amount of marine reptiles, including several mosasaur remains mainly referred to the Mosasaurines (Gasparini and Del Valle 1980, 1984, Martin et al. 2002, Martin 2006, Fernández and Gasparini 2012). However, up to date, most of these remains correspond to postcranial elements and/or isolated teeth. An exception is a fragmented skull and humerus recently described as the new tylosaurine *Kaikaifilu hervei*. (Otero et al. 2016).

In the present contribution, we describe a new specimen, recovered during the CAV 2015, from the López de Bertodano Fm. (Marambio Island, Antarctica) identified as *Mosasaurus* sp.. This new discovery represents one of the few, bigger and most complete *Mosasaurus* skulls from Antarctica for the upper Cretaceous.

2. Geological setting

The studied material was collected on the upper levels of the López de Bertodano Formation (Rinaldi et al. 1978) that outcrops on the central part of the Marambio (=Seymour)

Island, Antarctica (Fig 1.). The age of the formation was first assigned to Maastrichtian-Paleocene age based on mollusks (Zinsmeister 1979, 1982, Zinsmeister and Macellari 1988), microfossils (Huber 1988) and palynomorphs (Askin 1989). Later on, the age was further constrained to the Maastrichtian-early Danian (Olivero 2012). The López de Bertodano Formation (LBF) beds on Marambio Island are dominated by silt, with varying components of sand and clay, and have been interpreted as deposited on an open shelf, in water depths ranging from 10's of meters to ~200 meters (Macellari, 1988). Macellari (1988) divided the LBF ten informal units into two separate groups, the lower "*Rotularia* Units" (LB2-LB6), and the upper "Molluscan Units" (LB7-LB10). The lowest unit (LB1) has been redefined as the Haslum Crag Sandstone (Snow Hill Island Formation) (Olivero et al. 2008, Olivero 2012). Depending on the base of the section used and the particular study, this interval represents about 1100 stratigraphic meters, with approximately the lower ~600 meters corresponding to the *Rotularia* Units, and the iridium anomaly representing the K-Pg boundary located at the lithologically defined LB9-LB10 boundary (Elliot et al. 1994). Molluscan fossils are much less common in the *Rotularia* Units (which are dominated by fossils of the worm *Rotularia*) than the Molluscan Units, though they are not absent. Overall, water depth increases from possibly estuarine in the lower units to fully open shelf in the upper units (Olivero 2012).

The studied specimen has been recovered from the LB9 unit close to the K/Pg event zone at coordinates S 64º 16'; W 56º 44'.

3.Materials and methods

3.1. Materials and methods

The specimen described herein (MLP 15-I-24-41) was mechanically prepared at the Museo Nacional de la Plata (Argentina). Since the rock matrix was hard and the fossils were deeply embedded into it, a conjunction of chemical consolidates (Paraloid B-72) and pneumatic air scribes were used to separate most of the matrix from the fossils. Due to the matrix constitution and fossil fragility of some elements, the specimen was not completely prepared to prevent the breakage and disarticulation of these elements.

3.2. Institutional abbreviations

Institutional abbreviations used on this contribution are: MLP Museo Nacional de la Plata, Buenos Aires province Argentina, MML Museo Municipal de Lamarque, Rio Negro province, Argentina MNHN Muséum national d'Histoire naturelle, Paris, France.

4. Systematic paleontology

Class REPTILIA Linnaeus, 1758

Order SQUAMATA Oppel, 1811

Family MOSASAURIDAE Gervais, 1852

Subfamily MOSASAURINAE Gervais, 1852

Genus *Mosasaurus* Conybeare, 1822

Species *Mosasaurus sp.*

Referred specimen. MLP 15-I-24-41, a partial skull including, partial frontal, right postorbital, parietal, right quadrate, right posterior end of basisphenoid, right coronoid, right angular, splenial and right surangular, a broken marginal tooth and several pterygoid teeth have been associated to this specimen.

Locality and horizon. MLP 15-I-24-41 was recovered from the upper Maastrichtian LB9 unit from the Lopez de Bertodano Fm. at Marambio Island, Antarctica.

General considerations. (Fig. 2) MLP 15-I-24-41 was recovered as a single block with elements embedded on the matrix. Disarticulated vertebrae and teeth were also found in close proximity to the specimen. After mechanic preparation, many elements were isolated from the matrix while some others were kept enclosed in it because further preparation was hindered by the sediment consistency and risked damage of the elements preserved. Schematic illustrations of the preserved elements are shown in figure 2 (B-C) over a reconstruction of a mosasaur skull.

Frontal. (Fig. 3 A-D) The frontal is incomplete, preserving only its posterior end, including the fronto-parietal suture. Its right side is mainly covered by the matrix and by a displaced portion of the right splenial. Along its midline, both right and left sides are separated on the anterior end, and a well-developed sagittal crest is observed on its dorsal surface (Fig 3. A-B).

The posterior margin forms the fronto-parietal suture. The frontal projects two prongs that overlap over the parietal and embrace a region that bears the parietal foramen. The prongs are asymmetrical, thick medially and thin out posteriorly (Fig 3. A-B). The lateral contact between the parietal ala and the frontal is not straight and seems to be slightly curved.

Ventrally, the frontal has a deep sagittal groove that is bounded by a ridge on each side, the cristae cranii, forming the olfactory canal (Fig 3. C-D). Both the parietal and the postorbital articulate on the ventral surface. The postorbital articulation occupies a large area of the posterior end of the frontal. The parietal articulation ventrally is more complex. The parietal ala contacts with both the frontal and the postorbital. Medially the parietal underlies part of the frontal process of the postorbital and projects anteriorly. This anterior projection of the parietal is broken and its extension is not measurable.

Postorbitofrontal. (Fig. 3 C-D) Of the right postorbitofrontal, only the frontal articulation process is preserved. It is found on the ventral surface of the frontal. It has a flat square-like shape and contacts posteriorly with the parietal.

Parietal. (Fig. 3 E-F) The parietal preserves most of its anterodorsal portion. On its dorsal surface, the parietal slightly thins out toward its posterior end until it reaches the suspensory ramus divergence point. At this point, the ramus diverges laterally and the overall shape thickens once again. This second thickening never reaches the width of the anterior portion.

Anteriorly, the parietal is overlain by the frontal prongs close to the midline. The parietal then follows the frontal's outline forming the parietal ala of which only the left one is preserved on articulation with the frontal. The parietal foramen is not recognizable due to preservation, but it seems to be located between the frontal prongs. The lateral edges of the parietal table are sharp and form shelves that overhang the descending process of the parietal. The edges are almost parallel to each other until the divergence point.

Ventrally the parietal is longitudinally concave. Anteriorly the parietal has a complex articulation with the frontal. Laterally the parietal wings embrace the frontal and bend anteriorly articulating with the posterior and ventral surface of the postorbitofrontal which overlaps the frontal ventrally.

Quadrate. (Fig. 4 A-D) Only the articular condyle of the right quadrate and the ventral portion of the tympanic ala are preserved (Fig. 4 A-B), the medial surface is covered by sediment and other elements preventing observation of this surface. The articular condyle is convex and has a fusiform shape on ventral view (Fig. 4 C-D). There is a groove on the edge of the tympanic ala that almost reaches the condyle that seems to be caused by breakage. The overall morphology of the quadrate closely agrees to that of the ventral region of MNHN AC 9648 left quadrate (fig. 4 E-F, Street and Caldwell 2016, fig 13 a, f), however, MLP 15-I-24-41 articular condyle is relatively shorter.

Basisphenoid. (Fig. 4 G-H) Only the posterior region and an isolated fragment are preserved. The right articular lobule is preserved on its outmost lateral portion. The fragmentary element is interpreted as a medio-lateral portion of the right basisphenoid.

The right articular surface with the basioccipital is preserved. The articular lobule has a flabelliform shape with a slight concavity. Marginally the surface is covered by fine striations which are deeper and larger on the distal ventral region of the element. The hypothesis that these striations could be joint points with cartilaginous elements or pits to articular protuberances of the basioccipital has been proposed by Street and Caldwell (2016, p. 13 and fig. 10b).

Surangular. (Fig. 5 A-D) An incomplete right surangular is preserved on its posteroventral region, both internal and external surfaces are exposed, although the dorsal portion is covered by rock matrix (external surface), or by the superposition of another unknown element (internal surface).

The surangular is a roughly triangular shaped bone that composes the posterolateral end of the mandible on most of the postdentary unit. The dorsal and posterior surfaces are covered by sediments that could not be removed and most of the anteroventral region is not preserved. The lateral surface of the surangular (Fig. 5 A-B) is convex while the medial one is slightly concave (Fig. 5 C-D). The posterior surangular foramen can be recognized on the lateral wall close to the posterior and dorsal margin of the element, whereas the anterior one is not preserved.

The surangular forms the lateral wall of the glenoid fossa, this fossa forms a canal that runs from the posterodorsal margin of the surangular to the anterior end of this element. Ventrally the surangular is almost straight, the posterior end is the only region where it curves gently outwards.

Angular. (Fig. 6 A-B) The right angular is incomplete and only exposed in medial view. The anteroventral region is preserved including the articulation joint with the splenial. The posterior region is not preserved. Ventrally, the angular is straight. The dorsal margin of the angular is oblique, being inclined towards the posterior end of the bone forming an angle close to 40°. The articulation with the splenial is a convex surface that forms a condyle that is indented by a medial notch on the dorsal margin.

Splenial. (Fig. 6 C-D) A sheet of bone is found close to the angular. It is interpreted as part of the lateral region of the splenial. A groove runs through the ventral surface of the lateral face of the splenial. Part of the medial wing seems to be preserved but since is covered by sediments is hard to measure how much of it is present.

Coronoid. (Fig. 6 E-F) The right coronoid is found partially preserved. The best-preserved portion is the dorsal margin including the proximal segment of the ascending process of the coronoid. This process gives the signature anterolateral concave shape to the coronoid. Medially a groove runs on the lateral side of the ascending process of the coronoid. This groove then becomes a fossa on the lateral side of the coronoid. In cross-section the coronoid has a saddle-like shape. This saddle-like shape is given due to the bending of the lateral and medial wings of the coronoid which surrounds the articulation point for the surangular.

Teeth considerations. Most of the teeth were found in close proximity to the rest of the elements. However, only one pterygoid tooth was found in contact with the cranial elements. It could be that some of the teeth do not correspond with this specimen, but they are similar enough to be considered and grouped together with this specimen.

Marginal dentition. (Fig. 6 G-H) One of the recovered teeth can be assigned as a marginal one. The labial surface is the only region preserved. The tooth is slightly curved distolingually. The enamel is smooth and has at least three facets. No carinae are preserved.

Pterygoid teeth. Five small teeth (close to 2cm) (Fig. 6 I-L) where recovered. At the base, they have a circular to oval cross section (aspect ratio between 0.8 and 0.5). Most of the teeth are curved and robust distolingually on its central region (Fig.6 I-J), but some are thinner and have a more triangular outline (Fig. 6 K-L). The enamel shows fine striations that run throughout the crown. The labial surface is bulkier than the lingual one which is almost completely flat. The preserved carinae are smooth and do not have any serrations.

5. Remarks

5.1. On the affinities of the MLP 15-I-24-41 *specimen*

A large number of species have been referred to the genus *Mosasaurus* since it was proposed. However, subsequent studies many of such species have been found to be junior synonyms or to belong to other mosasaur genera (Rusell 1967, Bardet 1990, Mulder 1999, Lindgren and Siverson 2002, Lindgren 2005, Street and Caldwell 2016). Rusell (1967) provided the first detailed diagnosis of the genus and reduced it to eight valid species. However, Rusell (1967) based his diagnosis on the comparative and descriptive study of only North American taxa.

Street and Caldwell (2016) revised the type species *Mosasaurus hoffmannii* and also reviewed the genus *Mosasaurus* as a whole. As a result of their review ten species are now considered as valid, *M. hoffmannii* Mantell, 1829, *M. mokoroa,* Welles and Gregg, 1971, *M. missouriensis,* Harlan, 1834, *M. conodon,* Cope, 1881, *M. lemonnieri*, Dollo, 1889, *M. beauguei,* Arambourg, 1952, *M. dekayi,* Bronn, 1838, *M. hobetsuensis,* Suzuki, 1985, *M. flemingi* Wiffen, 1990a and *M. prismaticus,* Sakurai, Chitoku and Shibuya, 1999.

Only one diagnostic feature of *Mosasaurus sensu* Street and Caldwell (2016) has been preserved on MLP 15-I-24-41 and allows its identification on a generic level: the presence of posteromedial processes of the frontal invading deeply the parietal embracing the parietal foramen.

Comparisons within the genus proved to be more difficult because many of the species considered as valid by Street and Caldwell (2016), particularly those of the Pacific rim, are poorly known or need revision.

One trait that is consistent with three *Mosasaurus species* is the overall morphology of the recovered marginal tooth, which allows comparison with teeth from other plotosaurine mosasaurs. The ornamentation of the crown in the marginal teeth shows facets, this feature is shared by *M. hoffmannii*, *M. prismaticus* and *M. beauguei,* (Sakurai et al. 1999, Bardet et al. 2004, Street and Calwell 2016) whereas is lacking in *M. conodon* and *M. mokoroa* and is reduced in *M. hobetsuensis. M. dekayi* teeth closely agree with those of *M. hoffmannii,* however, Street and Caldwell (2016) argue that this species could be considered for reassignment in the future. But assignations based on teeth are problematic, in particular to Antarctic specimens because of the tylosaurine mosasaur Kaikaifilu hervei (Otero et al. 2016).

The taxonomic status of *Mosasaurus lemonnieri* is controversial. This species is recognized as a mosasaur with a striking resemblance to both *M. hoffmannii* and *M. missouriensis* being more gracile and smaller in size. Rusell (1967) proposed *M. lemonnieri* to be a junior synonym of *M. conodon*, however, this has since been refuted by Lingham-Soliar (2000) and Ikejiri and Lucas (2015). On the other hand, other authors have proposed that *M. lemonnieri* represents juveniles of *M. hoffmannii* (Mulder et al., 2004, as cited in Jagt, 2005) since most of the differences that differentiate them are only appreciated in ideal cases and seems to be ontogenetically variable. However, one feature that differentiates both species is the fact that M. lemonnieri has fluted tooth instead of faceted ones, so, until more conclusive evidence is found to support the synonimy of both taxa, M. lemonnieri remains valid.

Mosasaurus mokoroa and *Moanasaurus mangahouangae* Wiffen 1980, are two mosasaurine mosasaurs from the Campanian and Maastrichtian of New Zealand that are of interest for any mosasaurine mosasaur found in Antarctica. *M. mokoroa* has a series of features that differentiate it from other *Mosasaurus* species as was highlighted by Street and Caldwell (2016), and is still a valid species but in dire need of revision. The fragmentary nature of the specimen described here prevents further comparisons with *M. mokoroa* since most of the overlapping elements have the usual Plotosaurini features and diagnostic features are not recognized, however, as said above the marginal teeth are the only thing that differs between this specimen and the species.

Moanasaurus mangahouangae is a more interesting scenario, some mosasaur vertebrae from the upper Maastrichtian levels of the Lopez de Bertodano Fm. have been assigned to the *Moanasaurus* genus (Martin et al. 2002, Martin 2006). This is the only record outside New Zealand and it is interesting because it comes from the same levels the specimen herein described belongs. However, *Moanasaurus* has certain features that cannot be identified in this specimen, the fronto-parietal suture of *Moanasaurus* is different ventrally from that of *Mosasaurus*, the ventral surface of the frontal is ridged and fluted for the fluted anterior projections of the postorbital (Wiffen 1980, 1990b), here we don’t see any kind of ridges or flutening in the ventral surface and the portion of the postorbital preserved does not seem to be fluted as is the case in Moanasaurus. So affinities to this taxon are discarded for now. It is however imperative to revise this genus since it seems to have been even more diverse than previously thought (Street 2017).

As mentioned before, comparisons with the other species are hampered by the preservation state of MLP 15-I-24-41 and by the limited amount of comparative material available. In this context we consider it prudent not to propose a new name for the Antarctic specimen and refer MLP 15-I-24-41 as *Mosasaurus sp.*

5.2 Plotosaurini paleogeographic occurrence and history

Plotosaurini Bell 1997, is a clade that includes at least the genera *Mosasaurus* and *Plotosaurus* Camp 1951. The monophyly of the former genus has been challenged in recent studies, (LeBlanc et al. 2012, Street 2017) and some species from Belgium and Japan have been suggested to resemble more *Moanasaurus* than *Mosasaurus* (Street, 2017) which could imply than in a posterior revision of such species they might be reassigned to the later genus. The genus *Plotosaurus* is a mosasaur genus that has only been recovered from the Maastrichtian of the United States. Although some records of *Plotosaurus* from South America (Frey et al. 2016) and Japan (Obata et al. 1972) have been found, their validity as remains from the genus has been challenged (Caldwell and Konishi 2007, Jimenez-Huidobro et al. 2017) and assigned as Halisaurine and Russellosaurine mosasaur remains instead respectively.

For the benefit of the discussion, since *Moanasaurus* and *Mosasaurus* share morphological traits typically associated to Plotosaurini, *Moanasaurus* will be considered as a

Plotosaurini even though its phylogenetic position is still unresolved and the genus is need of revision.

Mosasaurus is one of the most common genus of mosasaur during the upper Campanian and Maastrichtian. It seems to have appeared almost suddenly worldwide since there are records of Campanian *Mosasaurus* species in different continents. During the Campanian, *Mosasaurus* was already present in Europe (*M. lemonnieri* Lingham-Soliar, 2000), New Zealand (*M. flemingi*, *M. mokoroa*, Welles and Greg 1971, Wiffen 1990a), Japan (*M. hobetsuensis, M. prismaticus* Suzuki, 1985, Sakurai et al., 1999) and North America (Russell 1967). There is a record from the Santonian beds of the Umzamba Formation of South Africa assigned to *Mosasaurus* sp., (Rogers and Schwarz 1902), however its validity as such under more recent diagnosis frameworks is still to be determined and it has never been regarded again since the original publication. This Santonian record will not be considered for this discussion since it is confusing, and addressing the date it was published it probably represent a specimen assigned to *Mosasaurus* when there was not a strong diagnosis for comparison with the genus (which was latter provided by Russell, 1967, with all the problems it had as was highlighted by Street and Caldwell, 2016).

Plotosaurini has a wide distribution in the Late Campanian, represented only by the *Mosasaurus* genus. Its closest relatives, (under recent phylogenetic frameworks, Jiménez-Huidobro and Caldwell 2016, Madzia and Cau 2017), Globidensini, *Plesiotylsaurus crassidens* Camp 1942 and *Eremiasaurus heterodontus* LeBlanc et al. 2012, have been recorded since the Campanian with a wide distribution as well, the latter two are from the Maastrichtian of North America and Morocco. This would mean that during the Campanian, or even before then, the lineages of Plotosaurini and Globidensini would have had to already started to disperse and diversify to account for the diversity and occurrence of both groups in Upper Campanian strata.

The next closely related taxa are assigned to the *Clidastes* genus, that is not recovered as monophyletic in modern phylogenetic frameworks (Jiménez-Huidobro and Caldwell, 2016, Madzia and Cau 2017). The species assigned to the *Clidastes* genus is known from the Coniacian of North America (Everhart 2001) up to the Campanian where it can be found in both North America and Europe (Russell 1967, Lindgren and Siverson 2004, Fig.7 A, B). It is noteworthy that *Clidastes* seems to have a pattern of dispersal during the Coniacian-Campanian eastward that partially resembles the original distribution of Plotosaurini during the Campanian, being present both in North America and Europe, however, this cannot explain the Campanian distribution of Plotosaurini since it does not account for the *Mosasaurus* species from Japan and New Zealand. What is more plausible is that the ghost lineages of both Globidensini and Plotosaurini would have originated somewhere in North America and used the same routes of dispersal that the *Clidastes* used eastward, and would have also found some kind of route westward to explain the Campanian Pacific occurrence of Plotosaurini.

During the Maastrichtian the distribution of Plotosaurini seems to extend southward from their Campanian locations both in the Atlantic and Pacific with records from Angola (Mateus et al 2012), Democratic Republic of Congo (Lingham-Soliar 1994), Niger (Lingham-Soliar 1991), Argentina (Fernández et al 2008) and Antactica (Martín et al. 2002, Martin 2006, Martin and Crame, 2006). At the end of the Maastrichtian the tribe has a worldwide distribution (Fig 7. C).

This scenario is interesting under the recently raised taxonomic uncertainties of certain species assigned to *Mosasaurus* (Street, 2017) and the possibility that those species could represent members of the *Moanasaurus* genus instead. If this is the case, we should expect that

Campanian species of *Mosasaurus* from the Pacific Rim to be more closely related between them and with *Moanasaurus* than to species of *Mosasurus* from Europe and Africa. Whereas North American species would be expected to be related to either of both groups. In the Maastrichtian these lineages expanded southward as is the only explanation for their Maastrichtian occurrence. The specimens that Street (2017) suspects might be *Moanasaurus* from Belgium could represent a posterior dispersion event from the Pacific to the Mediterranean.

The Antarctic Plotosaurini remains then should have either a Pacific or Atlantic identity. Some remains from the upper levels of the Lopez de Bertodano Fm. have been assigned as *Moanasaurus* sp. by Martin et al. (2002), which would support Pacific affinities in the Antarctic Plotosaurini faunas. However, there are uncertainties and an Atlantic affinity cannot be ruled out since most of the Antarctic Plotosaurini remains are fragmentary and their taxonomy, problematic. To solve this issue, a taxonomic and phylogenetic revision of the pacific rim *Mosasaurus* and *Moanasaurus* is needed. Until these problems have been addressed the specimen herein described will be assigned as *Mosasaurus* sp.

6. Conclusions

MLP 15-I-24-41 is identified as *Mosasaurus sp.* based on the anatomy of traits such as the fronto-parietal suture, quadrate and teeth morphology. Some features of northern Patagonia and Antarctic materials allow hypothesizing that they may correspond to a new species. However, no new names are proposed for these specimens as the fossil record is still very incomplete, and the increase of scientific names based on incomplete and/or poorly known or dubious records will hamper (instead of improve) the resolution of the controversial remaining topics on austral mosasaurs. It could however be reassigned in the future to Moanasaurus sp. if the uncertainties surrounding Pacific Rim mosasaurus get clarified.

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FIGURE CAPTIONS:

FIGURE 1. Schematic map of Marambio (=Seymour Island), showing the main geological units. The star represents the type locality where the specimen was collected. The stratigraphic position of MLP 15-I-24-41 is shown on the right side (Taken and modified from O’Gorman et al. 2017).

FIGURE 2**.** MLP 15-I-24-41 elements relative field position and orientation (**A**) and anatomical correspondence of elements (**B**-**C**, taken and modified from Street and Caldwell 2016). **Abbreviations:** an, angular. bsp, right basisphenoid. c, right coronoid. f, frontal. pa, parietal. pi, parietal foramen. sp, splenial. sur, surangular. un, unknown element. Scale bar = 5cm.

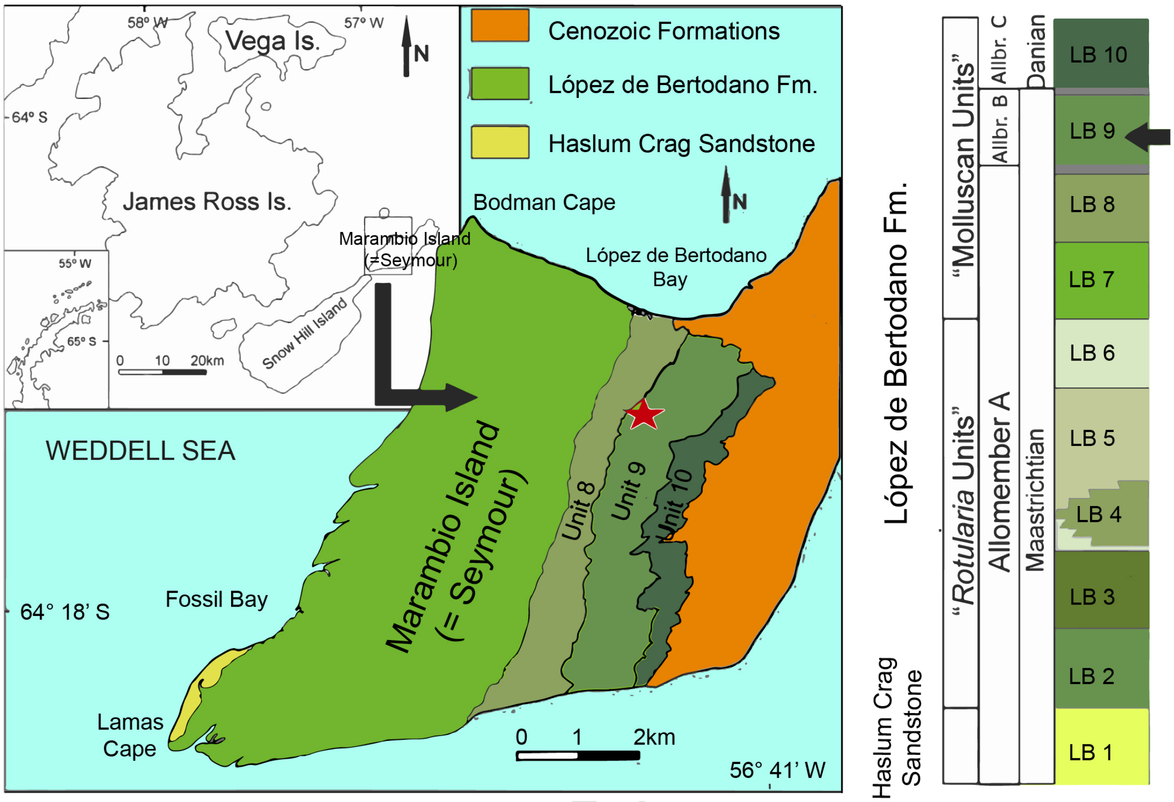
FIGURE 3. MLP 15-I-24-41 frontal in dorsal (**A**-**B**) and ventral (**C**-**D**) views; and parietal on dorsal view (**E**-**F**). **Abbreviations:** co, olfactory canal. f, frontal. flw, frontal lateral wing. fmp, frontal medial prongs. pa, parietal. paa, parietal ala. pi, parietal foramen. po, postorbitofrontal. psr, parietal suspensory ramus. sc, sagittal crest. Scale bar =5cm

FIGURE 4. MLP 15-I-24-41 right quadrate on lateral (**A**-**B**) and ventral (**C**-**D**) views. MNHN AC 9648 left quadrate (mirrored) (**E**-**F**, taken and modified from Street and Caldwell 2016) Right basisphenoid on posterior view (**G**-**H**), only the right articular facet with the basioccipital is preserved. **Abbreviations:** ba, basisphenoid-basioccipital articulation surface. fg, fibrous grooves. mcd, mandibular condyle. ptw, posterior tympanic wall. tc, tympanic conch. Scale bars = 5cm.

FIGURE 5. MLP 15-I-24-41 right surangular in lateral (**A**-**B**) and medial (**C**-**D**) views. **Abbreviations:** psrf, posterior surangular foramen. smc, surangular Meckelian canal. un, unknown element.

FIGURE 6. MLP 15-I-24-41 right angular (**A-B)**, splenial (**C**-**D**), coronoid (**E**-**F)** and associated teeth (**G-L),** marginal with three facets on labial view (**G-H),** a stout pterygoid tooth (**I**-**J)** on lingual view and a flatter one (**K-L)** on the same view. **Abbreviations:** ap, ascending process of the coronoid. ca, unserrated carinae. st, striations. fa, facets. g, groove. sa, splenial articulation surface of the angular. Scale bar = 5cm (**A**-**F**) =2cm (**G**-**L**).

FIGURE 7. *Clidastes*, *Mosasaurus* and *Moanasaurus* paleogeographic occurrence during (A) the Coniacian and Santonian, (B) Campanian and (C) Maastrichtian. Maps were generated using the mapast package for R (Varela and Sonja Rothkugel 2018).


Cenozoic Formations
López de Bertodano Fm.
Haslum Crag Sandstone
58° W
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Vega Is.
64° S
James Ross Is.
Marambio Island
(=Seymour)
Snow Hill Island
55° W
65° S
0 10 20km
Bodman Cape
N
López de Bertodano
Bay
WEDDELL SEA
Marambio Island
(= Seymour)
Unit 8
Unit 9
Unit 10
64° 18' S
Fossil Bay
Lamas
Cape
0 1 2km
56° 41' W
López de Bertodano Fm.
Haslum Crag
Sandstone
"Molluscan Units"
"Rotularia Units"
Allbr. C
Allbr. B
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Maastrichtian
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LB 8
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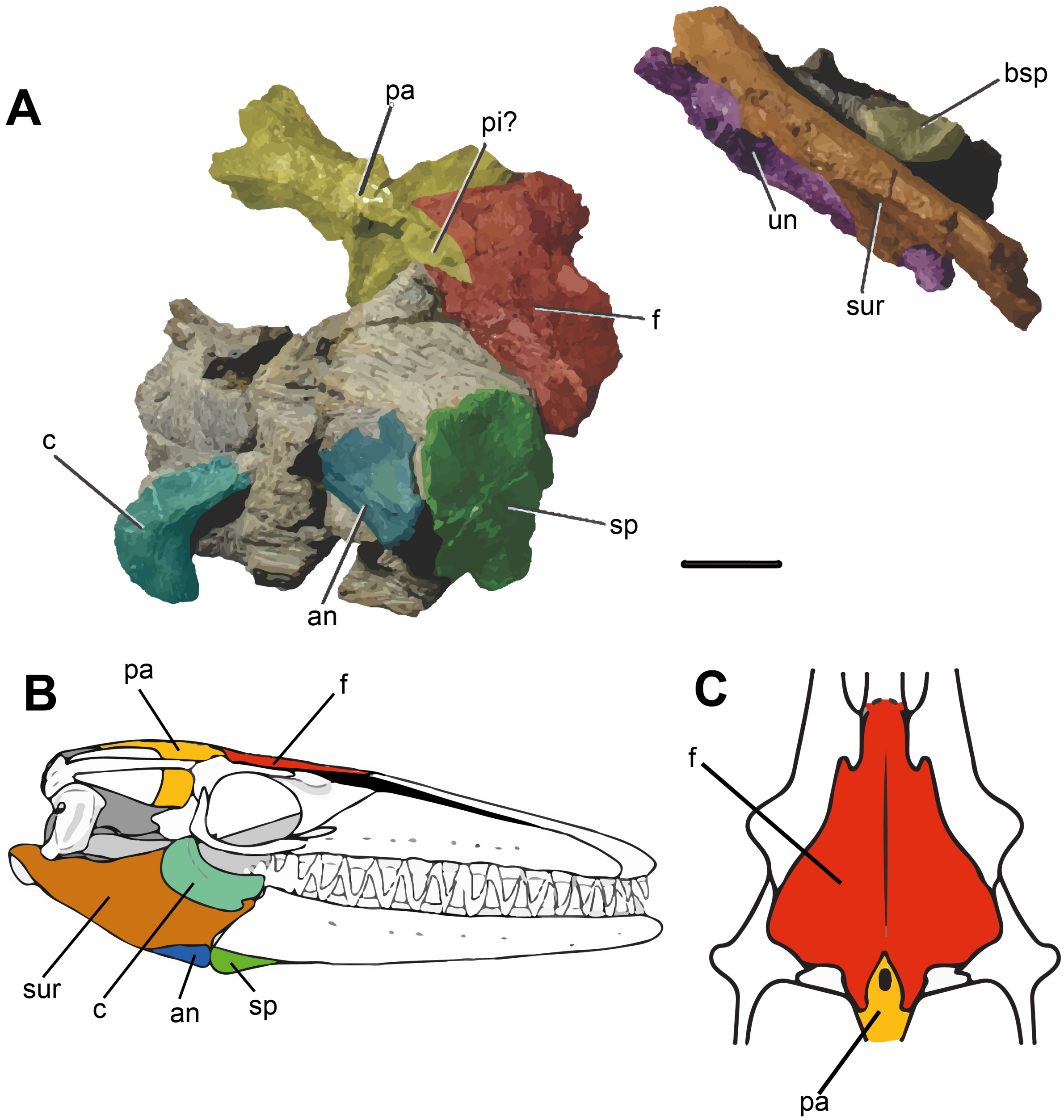
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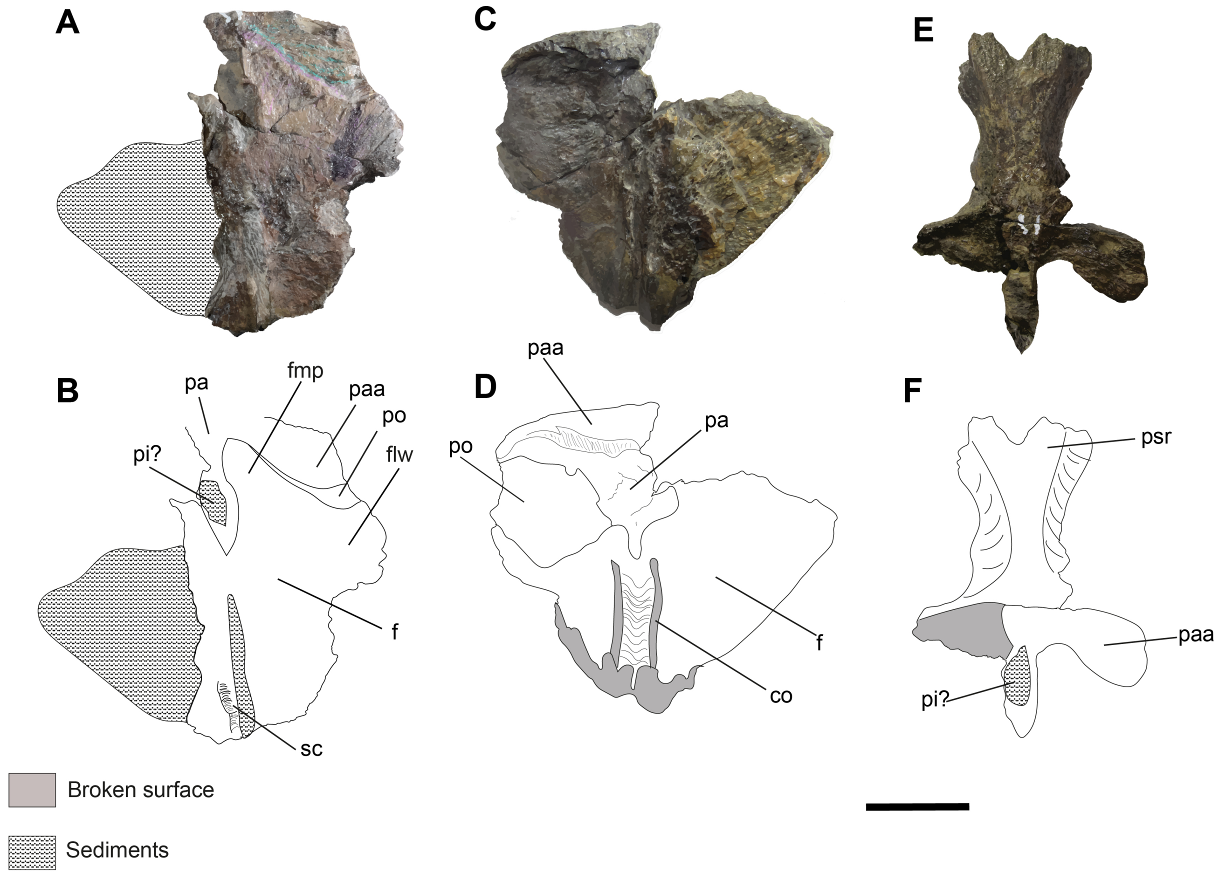
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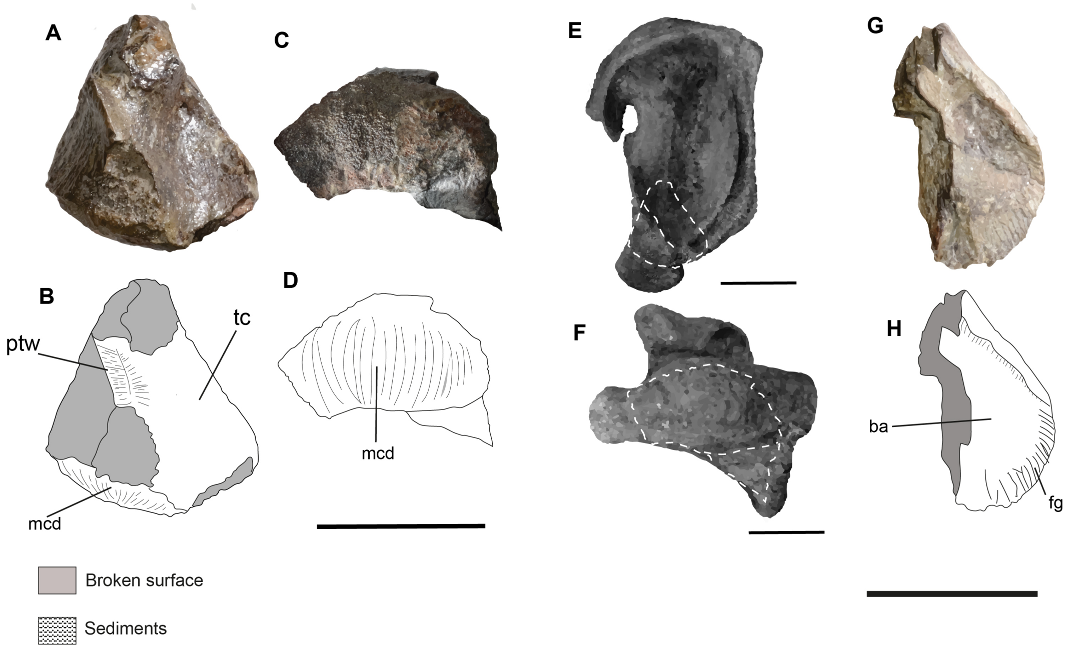
Sediments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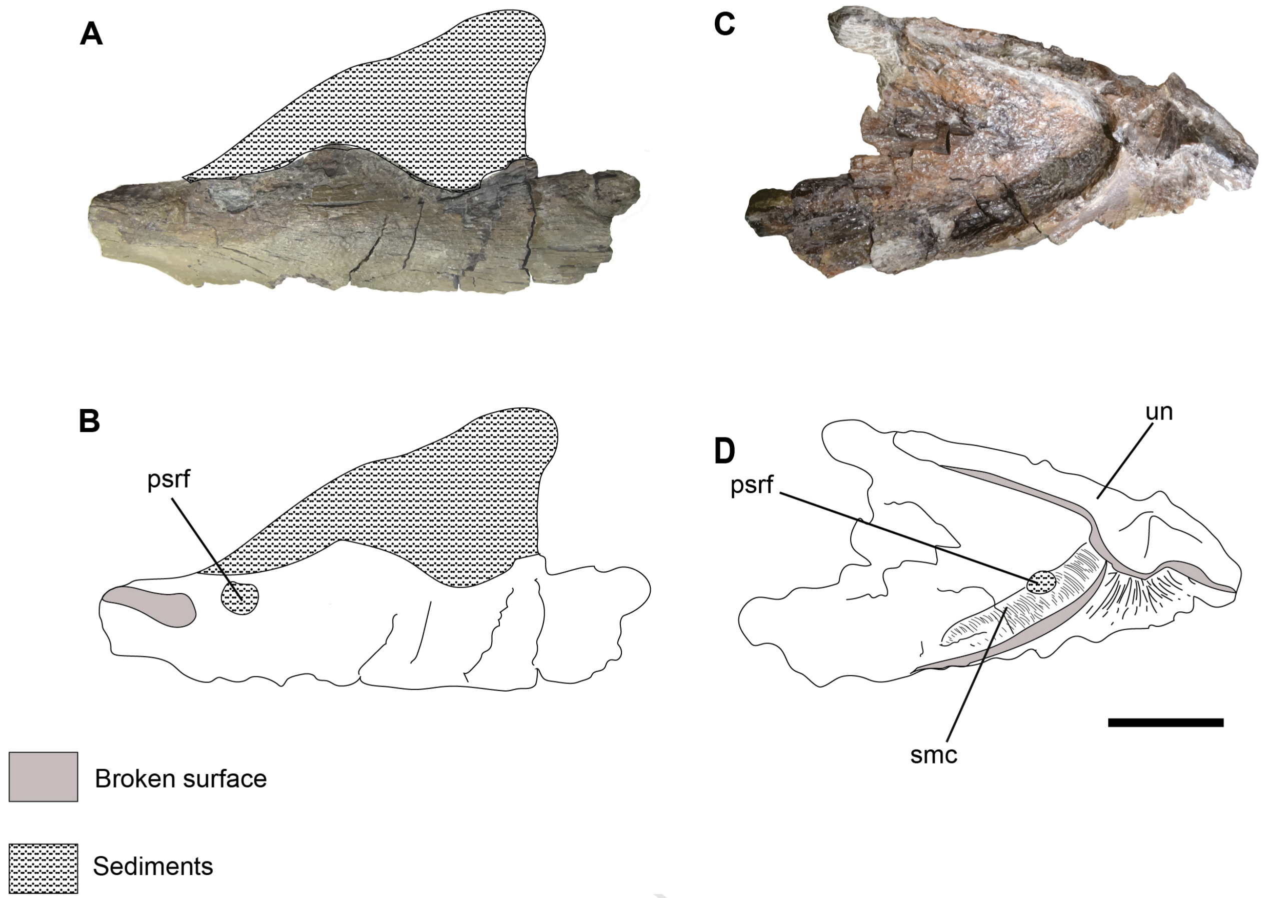
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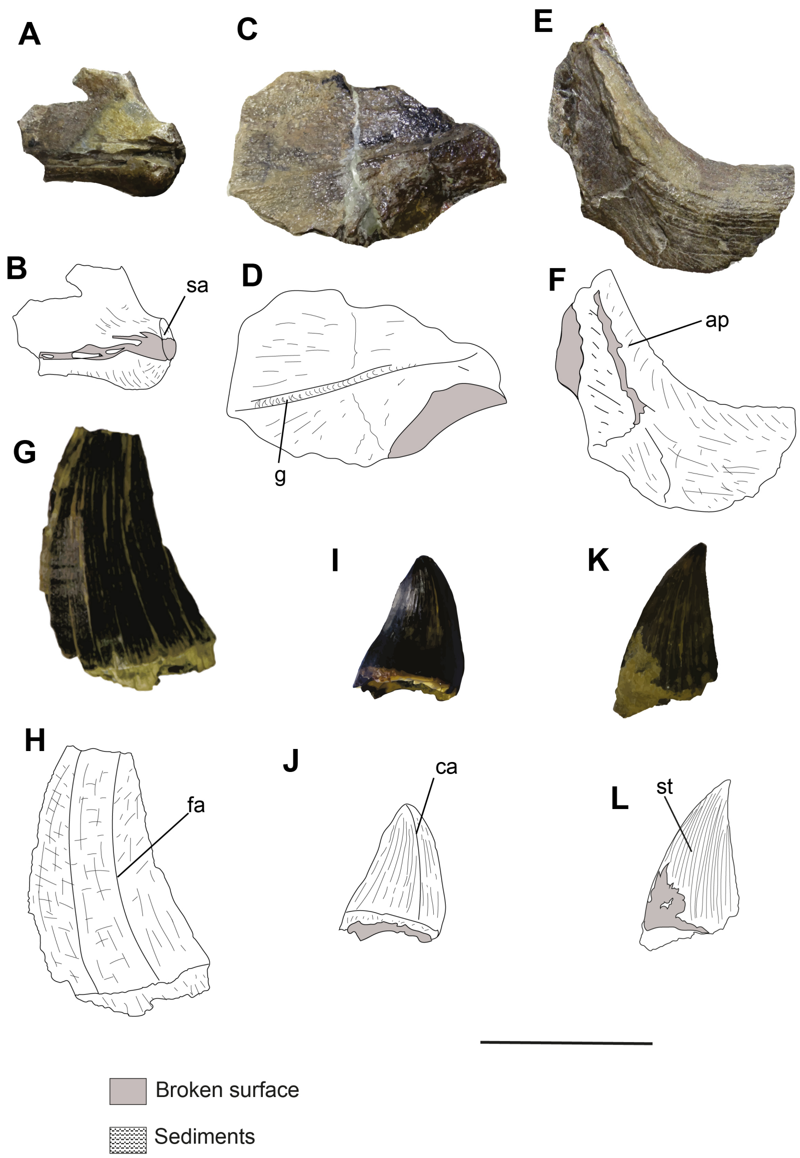
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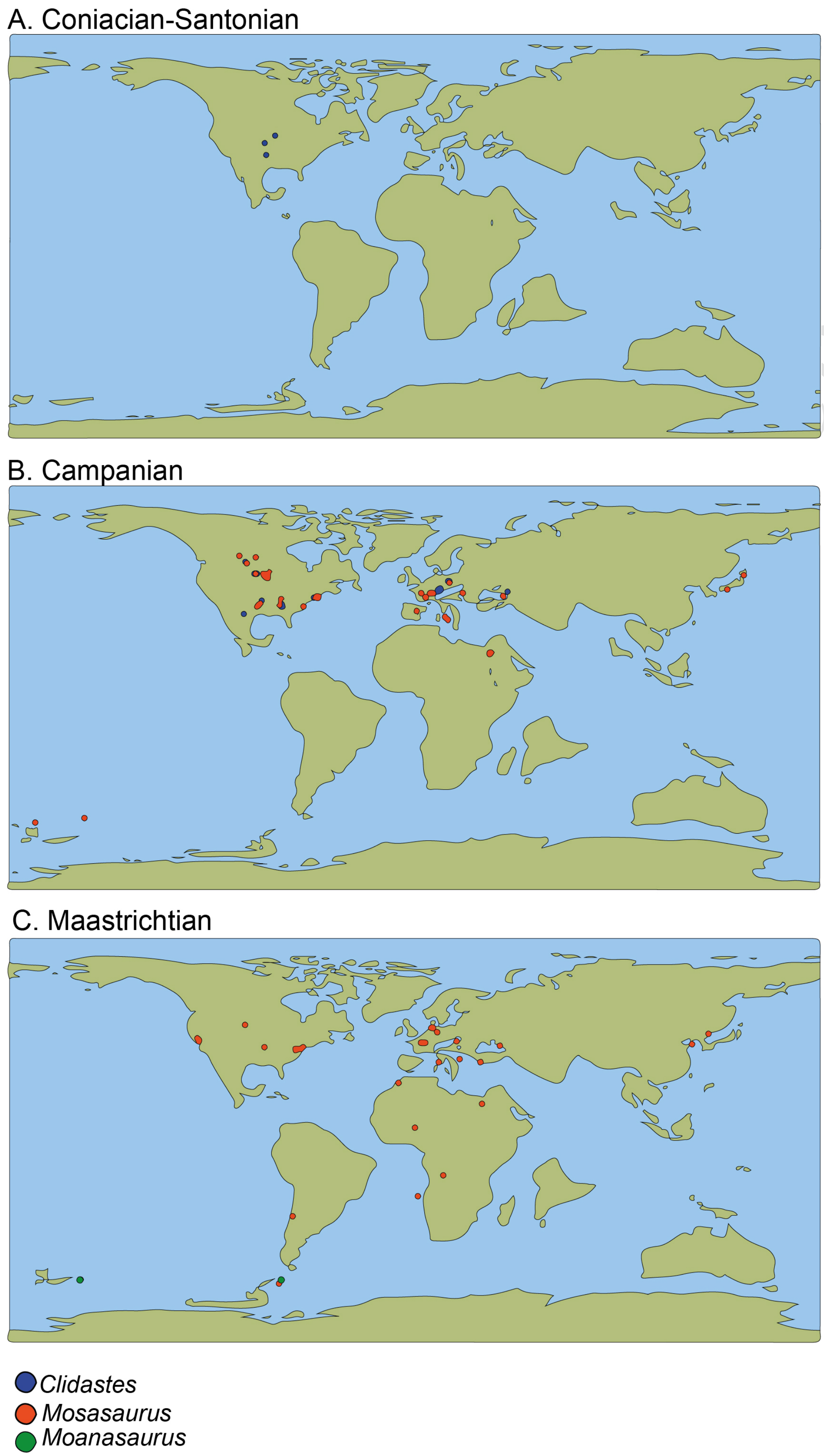
A. Coniacian-Santonian
B. Campanian
C. Maastrichtian
Clidastes
Mosasaurus
Moanasaurus

Highlights

- A new mosasaur skull from Antarctica
- The cosmopolitan status of a widespread taxa is questioned
- The new findings shed light in the dispersion of plotosaurine mosasaurus in the Late Cretaceous.